

below normal; the greatest monthly amount, 3.39, occurred at Pittsburgh, and the least, 0.20, at Honesdale.

The characteristic features of April were its three distinctive periods of decided temperature conditions, which prevailed during the first, middle, and latter part of the month. From the 1st to the 12th the continued cold weather almost completely held in check all visible signs of growth in vegetation, and spring seemed to make no advancement. This period of cold was followed by one of ten days of torrid heat. During this period growth was as marvelous as the unprecedented heat. Cereals and grasses sprang up as if by magic, trees burst into leaf and blossom, and the face of nature was rapidly changed from its dress of winter to its garb of spring. This rapid growth was somewhat checked by the cool weather which followed and prevailed from the 22d to the end of the month. The season, which was backward at the beginning of April, was fully up to the average at its close. Numerous frosts were reported on the 23d, but they were not damaging.

South Carolina.—The mean temperature was 66.9°, or 4.1° above normal; the highest was 98°, at Gillisonville on the 17th, and the lowest, 30°, at Santuc on the 9th. The average precipitation was 1.31, or 1.83 below normal; the greatest monthly amount, 2.46, occurred at Mount Carmel, and the least, 0.19, at Yemassee.

South Dakota.—The mean temperature was 47°, or about 3° above normal; the highest was 93°, at Faulkton on the 27th, and at Nowlin on the 26th, and the lowest, 4°, at Clark on the 2d, and at Wentworth on the 1st. The average precipitation was 4.85, or 2.50 above normal; the greatest monthly amount, 8.30, occurred at Webster, and the least, 1.39, at Cross.

Tennessee.—The mean temperature was 64.8, or more than 5.0° above normal; the highest was 98°, at Andersonville on the 25th, and the lowest, 25°, at Cookeville and Greenville on the 4th. The average precipitation was 3.70, or about 0.50 below normal; the greatest monthly amount, 6.50, occurred at Tullahoma, and the least, 1.70, at McKenzie.

Texas.—The mean temperature was 1.2 above normal; the highest

was 104°, at Fort Ringgold on the 29th, and the lowest, 15°, at Happy on the 2d. The average precipitation was 1.22 below normal; the greatest monthly amount, 6.14, occurred at Kerrville; there was no precipitation at Midland and Sierra Blanca.

Utah.—The mean temperature was 41°; the highest was 87°, at Cisco on the 25th, and the lowest, 1° below zero, at Grover on the 1st. The average precipitation was 1.07; the greatest monthly amount, 3.83, occurred at Park City, and the least, "trace," at Castlegate, Cisco, and Giles.

Virginia.—The mean temperature was 58.6°; the highest was 100°, at Bonair on the 18th and 19th, and the lowest, 10°, at Guinea on the 8th. The average precipitation was 1.61, which is decidedly below the normal; the greatest monthly amount, 3.71, occurred at Blacksburg, and the least, 0.41, at Alexandria.

Washington.—The mean temperature was 45.1°, or 1.9° below normal; the highest was 80°, at Connell on the 25th, and the lowest, 12°, at Cascade Tunnel on the 1st and 3d. The average precipitation was 3.85, or 0.07 above normal; the greatest monthly amount, 9.91, occurred at Queets, and the least, 0.29, at Moxee.

West Virginia.—The mean temperature was 57.9°, or about 6.0° above normal; the highest was 95°, at Point Pleasant on the 18th, and the lowest, 12°, at White Sulphur Springs on the 8th. The average precipitation was 2.06, or 1.30 below normal; the greatest monthly amount, 4.35, occurred at Wheeling, and the least, 0.82, at Raleigh.

Wisconsin.—The mean temperature was 46.0°, or 2.0° above normal; the highest was 87°, at Prairie du Chien on the 15th, and the lowest, 7° below zero, at Spooner on the 5th. The average precipitation was 5.02, or more than twice the normal; the greatest monthly amount, 8.19, occurred at Viroqua, and the least, 1.18, at Crandon.

Wyoming.—The mean temperature was 41.0°, or about 1.0° above normal; the highest was 84°, at Fort Laramie on the 27th, and the lowest, 2° below zero, at Wise on the 18th. The average precipitation was 1.63, or slightly below normal; the greatest monthly amount was 3.53, at Laramie, and the least, 0.55, at Wheatland.

SPECIAL CONTRIBUTIONS.

RECENT PUBLICATIONS ON METEOROLOGY.

By Dr. J. H. McCARTY, Librarian Weather Bureau.

In response to requests from several correspondents, the Chief of the Weather Bureau has directed that there be published regularly in this REVIEW a list of recent publications bearing on meteorology and such other subjects as come within the field of study of the officials of the Weather Bureau. In this list of authors and titles the works that have been received by the Library of the Weather Bureau will take precedence, but other works whose titles are known will also be mentioned, although they have not yet been received, in order that the correspondents of the Weather Bureau may thus receive early notice of the publication of works in which they are interested. It is to be understood, however, that those who wish to consult the works on meteorology received by the Weather Bureau must do so in its own Library, where every convenience for study is afforded, as, in fact, is also the case in all the other scientific libraries in Washington.

Argentina.—*Boletino del Instituto Geografico Argentino*. Publicado bajo la direccion del Sr. Presidente del Instituto, Dr. Alejandro Sorondo. Tomo XVII—cuadernos 1, 2, 3. 119 pp. 2 maps. Svo. Buenos Aires. 1896.

Batavia.—*Observations made at the magnetical and meteorological observatory at Batavia in the year 1894, with appendix*. Vol. XVII. Published by the Government of Netherlands in India. 233 pp. 14 by 10. Batavia. 1895.

Batavia.—*Rainfall in the East India Archipelago*. Sixteenth year, 1894. 421 pp. Svo. Batavia. 1895.

England.—*Results of meteorological observations made at the Radeliffe Observatory, Orford, in the years 1888-1889 under the superintendence of Edward James Storrs, F. R. S.* Vol. XLV. Svo. Oxford. 1896.

England.—Burrough of Southport, Fernley Observatory. Meteorological Department. *Report and results of observations for the year 1895*. Two appendices. Joseph Baxendal, Meteorologist to the Corporation. 31 pp. Svo. Southport. 1896.

England.—Liverpool Observatory, Bidston, Birkenhead. Report of the Director of the Observatory to the Marine Committee and meteorological results deduced from the observations taken in the year, 1895. 40 pp. Svo. Liverpool. 1896.

MacDowell, Alex. B.—*Weather and Disease*. A curve history of their variations in recent years. 82 pp., with charts. Large 12mo. London. 1895.

France.—Service hydrometrique du Bassin de la Seine.—*Resume des observations centralisees (par le Service Hydrometrique du Bassin de la Seine) pendant l'annee 1894*. 56 pp. Svo. Versailles. 1895.

France.—Service hydrometrique du Bassin de la Seine. Observations sur les cours d'eau et la pluie centralisees pendant l'annee, 1894. Mr. G. Lemoine et Mr. Babinet, ingenieurs. 7 feuilles folio. Versailles. 1895.

Germany.—*Annalen der Physik und Chemie*. Neue Folge. Band. LVIII. No. 5. 205 pp. Svo. Leipzig. 1896.

Great Britain.—*Official Year Book of the scientific and learned societies of Great Britain and Ireland*. Comprising a list of the papers read during the year 1895. Thirteenth annual issue. 262 pp. Svo. London. 1895.

Hamburg.—*Jahrbuch der Astronomie und Geophysik* enthaltend die wichtigsten Fortschritte auf den Gebieten der Astrophysik, Meteorologie, und physikalischen Erdkunde. Von Dr. Hermann J. Klein. VI Jahrgang. 1895. 5 Lichtdruck und Chromotafeln. 376 pp. Svo. Leipzig. 1896.

Hamburg.—Aus dem Archiv der Deutsche Seewarte. XVIII Jahrgang. 1895. Herausgegeben von der Direction der Seewarte. No. 1.—*Oberflächentemperatur und Stromungsverhältnisse des Aequatorialgürtels des Stillen Ozeans*. Von Dr. Casar Puls. (See Met. Zeit. Heft. 5, 1896. Bibliographie.) No. 2.—*Bericht und Gutachten über der Versuche bezüglich der Abblendung der Schiffs-Seitenlichter*. Ausgeführt im Sommer, 1895, auf Anordnung des Reichs Marine amtes, von der Direktion der Deutschen Seewarte. Mit einer Kurven-Tafel. No. 3.—*Vergleichende Regenmessungen an der Deutschen Seewarte*. Von Prof. Dr. W. J. Van Bebber. Mit 1 lithograph Tafel. No. 4.—*Der Isobarentypen des Nord atlantischen Ozeans und Westeuropas, ihre Beziehungen zur Lage und Bewegung der barometrischen Max. und Min.* Prof. Dr. W. J. Van Bebber und Prof. Dr. W. Koepfen. Mit 23 lithog. Karten. No. 1, 38 pp.; No. 2, 28 pp.; No. 3, 14 pp.; No. 4, 27 pp. 4to. Hamburg. 1895.

Holland.—Rotterdam. A magnetic survey of the Netherlands for the epoch January 1, 1891. By Dr. Van Rijckevorsel. Part 1, *The observations*; Part 2, *The disturbances*. 103 pp. 10 maps. 4to. Rotterdam. 1895.

India.—Madras Observatory. *Daily meteorological means*. By C. Michin Smith, Government Astronomer. Includes mean hourly barometric variations from daily means for 20 years. 14 pp. 4to. Madras. 1896.

- Klagenfurt.**—*Diagramme der magnetischen und meteorologischen Beobachtungen zu Klagenfurt.* Von Ferdinand Seeland. Witterungsjahr, 1894. December, 1893–November, 1894. 7 charts. 4to.
- Lisbon.**—*Annaes do Observatorio do Infante D. Luiz.* Trigesimo. Setimo Anno. 1891. Vol. XXIX. 139 pp. Fol. Lisbon.
- The same. Octavo Anno. 1892. Vol. XXX. 139 pp. Fol. Lisbon.
- Mexico.**—*Boletin mensual meteorologico y agricola del Observatorio Central del estado de Vera Cruz Llave.* 8 pp. 4to. Xalapa-Enriquez. 1896.
- Netherlands.**—*Archives Neerlandaises des sciences exactes et naturelles.* Tome XXX. Ire. livraison. Soc. Holland. d. Sciences. J. Bosscha, Secr. 99 pp. 8vo. Harlem, 1896.
- Nova Scotia.**—Proceedings and transactions of the Nova Scotian Institute of Science. Sessions of 1894–95. Vol. IX being Vol. II of the second series. Part I. 6 plates. 100 pp. 8vo. Halifax. 1896.
- Roumania.**—L'Institut Meteorologique. *Annales de l'Institut Meteorologique de Roumanie pour l'annee 1894.* Par Stefan C. Hepites. Tome X. In parts. 4to. Bucarest et Paris. 1895.
- Russia.**—Expedition der Kaiserlich. Russischen Geographischen Gesellschaft. *Beobachtungen der Russischen Polarstation an der Lena-mündung.* 1 Theil: *Astronomische und magnetische Beobachtungen,* 1882–84. Bearbeitet von V. Fuss, F. Mueller, und N. Juergens. Herausg. unter Redaction von Dr. A. von Tillo. Portraits. Russ. and German text. 4to. 1895.
- Saxony.**—*Bericht über die Thätigkeit im Königl. Sächsischen meteorologischen Institut für das Jahr 1894.* Mit 6 Anhängen und 4 Tafeln. XII Jahrg. 2te Hälfte. Prof. Dr. Paul Schreiber, Director. 81 pp. 4 Tafeln. 4to. Chemnitz. 1895.
- South Africa.**—Colony of Natal. *Annual report of the Superintendent of the Natal Observatory for the year 1894–95.* 41 pp. Fol. Pietermaritzburg. 1896.
- United States of America.**—Proceedings of the American Association for the Advancement of Science.—*Forty-fourth meeting held at Springfield, Mass., August-September, 1895.* Pages CXIX, 414. 8vo. Salem, Mass. 1896.
- California.**—*Report of work of the Agricultural Experiment Stations of the University of California for the year 1894–95, being a part of the Reports of the Regents of the University.* E. W. Hilgard, Director. Illustrated. 481 pp. 8vo. Sacramento. 1896.
- Hyde, G. A.**—Voluntary Observer U. S. Weather Bureau. Forty years of weather at Cleveland, Ohio. 33 pp. 8vo. Cleveland. 1896.
- Maryland.**—*The climatology and physical features of Maryland.* Second biennial Report of the Maryland State Weather Services for the years 1894, 1895. 110 pp. 5 maps. Baltimore. 1895.
- Noyes, Isaac P.**—*Phenomenal heat of 1896.* Reprint from Providence (R. I.) Journal of May 10, 1896. 4 pp. 8vo. Washington. 1896.
- Yale University.**—Astronomical Observatory. *Researches with the Heliumeter.* Triangulation of the principal stars of the cluster in Coma Berenices. By Fred. L. Chase, Assistant Astronomer. Vol. I. Pt. V. Pages 213–254. 4to. New Haven.
- Bureau of American Republics.**—Monthly Bulletin, Vol. III. No. 11. **Brazil.**—*Minerals and mining industries.* **Costa Rica.**—*Sugar industry.* **Guatemala.**—*Tariff changes in English and Spanish.* **Mexico.**—*Trade of Vera Cruz.* Amendment to the Constitution abolishing Inter-State duties. Pages 613–680. Supplement. 8vo. Washington, D. C. 1896.

KITE EXPERIMENTS AT THE WEATHER BUREAU.

By C. F. MARVIN, Professor of Meteorology, U. S. Weather Bureau (dated July, 1896).

In November, 1895, the present writer was directed by Prof. Willis L. Moore, the Chief of the Weather Bureau, to consider the subject of devising kites and auxiliary apparatus for the meteorological exploration of the upper air. The definite object was to attain a height of at least 1 mile and, if possible, 10,000 feet or more, and to bring down continuous records of temperature, moisture, pressure, and wind. A considerable acquaintance with the present state of the art of making and flying kites showed that both the form of the body of the kite and the analysis of the action of the forces that affected it demanded fuller consideration than had hitherto been given. In view of the rapidly increasing interest in this subject it seems proper to lay before the cooperating observers of the Weather Bureau the results that have been attained during the past few months, in order that those interested in the subject may in conducting their own experiments, profit by our experience.

With the advance of the science of meteorology, and especially with the progress in the development of the fundamental laws governing atmospheric phenomena, a growing

need arises for accurate knowledge of the conditions of the atmosphere with respect to its motion, temperature, pressure, moisture, etc., not only near the surface of the earth but particularly in the higher strata, where the forces in action have full scope and their effects are unmodified by such disturbing influences as exist near the surface.

Meteorological stations have been maintained on lofty mountain summits, in order to procure the desired information, and many perilous balloon voyages have been made with the express object of making accurate measurements of the atmospheric conditions at all elevations. Some use has been made of captive balloons, and within a few years remarkable results have been obtained in Europe by the use of free balloons of small size equipped with automatic instruments. Having no load of ballast to carry, these balloons when set free shoot upward with great velocity and attain very lofty elevations, whereupon, losing all effective lifting force by reason of the expansion and overflow of gas incident to the great diminution of pressure in the rarified strata of air, the partially inflated bag falls to the earth after a comparatively short journey. A notice attached to the balloon gives instructions respecting its disposition, and the finder receives a small reward for its safe return.

It appears, however, that even before balloons were invented, Dr. Alexander Wilson of Glasgow employed tandems of kites "to explore the temperature of the atmosphere in the higher regions." I am indebted to Professor Abbe for the following extract¹ giving an account of Dr. Wilson's experiments, which, owing to their early date and complete and interesting character, deserve special mention:

* * * * *

Among the more advanced students, who, in the years 1748 and 1749 attended the lectures on Divinity in the University, was Mr. Thomas Melvill, so well known by his mathematical talents, and by those fine specimens of genius which are to be found in his posthumous papers, published in the second volume of the *Edinburgh Essays, Physical and Literary*. With this young person Mr. Wilson then lived in the closest intimacy. Of several philosophical schemes which occurred to them in their social hours, Mr. Wilson proposed one, which was to explore the temperature of the atmosphere in the higher regions, by raising a number of paper kites, one above another, upon the same line, with thermometers appended to those that were to be most elevated. Though they expected, in general, that kites thus connected might be raised to an unusual height, still they were somewhat uncertain how far the thing might succeed upon trial. But the thought being quite new to them, and the purpose to be gained of some importance, they began to prepare for the experiment in the spring of 1749.²

Mr. Wilson's house at Camlachie was the scene of all the little bustle which now became necessary, and both Mr. Melvill and he, alike dexterous in the use of their hands, found much amusement in going through the preliminary work, till at last they finished half a dozen large paper kites, from 4 to 7 feet in height, upon the strongest, and at the same time upon the slightest construction the materials would admit of. They had also been careful in giving orders early for a very considerable quantity of line, to be spun of such different sizes and strength, as they judged would best answer their purpose; so that one fine day, about the middle of July, when favored by a gentle, steady breeze, they brought out their whole apparatus into an adjoining field, amidst a numerous company, consisting of their friends and others, whom the rumor of this new and ingenious project had drawn from the town.

They began with raising the smallest kite, which being exactly balanced, soon mounted steadily to its utmost limit, carrying up a line, very slender, but of strength sufficient to command it. In the meantime the second kite was made ready. Two assistants supported it

¹ Extract from Biographical account of Alexander Wilson, M. D., late Professor of Practical Astronomy in Glasgow, by the late Patrick Wilson, A. M., Professor of Practical Astronomy in the University of Glasgow. *Transactions of the Royal Society of Edinburgh*, Vol. X, Part II, pp. 279–297. 1825.

This memoir of Dr. Wilson, after being read at the Royal Society, February 2, 1789, was withdrawn by its author for the purpose of making some alterations upon it, and was never returned for publication. It was found, however, among the papers of Mr. Patrick Wilson, and is now printed with the consent of his family.

² As no public notice has hitherto been taken of this matter, though Mr. Wilson had always some thoughts of doing so, it is hoped that the following detail will not prove unacceptable or tedious to the reader.